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One of 12 ERTS-1 projects conducted by the University of Alaska
ERTS-1 project, GSFC No. 110-1
Principal Investigator, GSFC ID No. UN 318

16. Abstract

The objective of this project is to provide a focus for the entire University of Alaska ERTS-1 effort (12 projects covering 10 disciplines and involving 8 research institutes and science departments).

During the reporting period activities have been concentrated on the implementation of the project's three primary functions: (1) Coordination and management of the U of A ERTS-1 program, including management of the flow of data and data products; (2) Acquisition, installation, test, operation and maintenance of centralized facilities for processing ERTS, aircraft and ground-truth data; (3) Development of photographic and digital techniques for processing and interpreting ERTS-1 and aircraft data. With minor exceptions these three functions are now well-established and working smoothly. In the process of developing data processing techniques several data analyses have been performed, in particular a new vegetation map of the western Seward Peninsula has been produced, and a resource analysis of the Anaktuvuk Pass region of the Brooks Range have been performed.

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(E73-10307) COORDINATION AND ESTABLISHMENT OF CENTRALIZED FACILITIES AND SERVICES FOR THE UNIVERSITY OF ALASKA ERTS SURVEY OF THE (Alaska Univ., Fairbanks.) 27 p HC $3.50 CSCL 14B

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I - INTRODUCTION

This report summarizes the work performed and the conclusions reached during the first six months, August 1972 through January 1973, of Contract NAS5-21833, ERTS-1 Project 110-1, titled "Coordination and Establishment of Centralized Facilities and Services for the University of Alaska ERTS Survey of the Alaskan Environment". Three primary objectives were sought during this reporting period, coordination and management of the multi-disciplinary University of Alaska ERTS program, establishment of data storage and processing facilities, and development of digital and photographic processing techniques for ERTS and aircraft data.

The coordination activities have proven exceedingly beneficial in establishing effective information interchanges from projects in separate disciplines, as well as the necessary functions of cataloguing, filing, and transmitting the incoming data to the proper investigator.

Image processing facilities were established to produce false color images from the multiband 70mm positive transparencies using optical combining techniques. A LogE-tronics scan-modulated printer was put into operation for use in compressing the extreme density ranges of some images so as to provide more useful prints for some applications. The one problem area with the establishment of the planned facilities is the delay in installation of the CDU-200 color display unit. Unresolved interface problems have held up the shipment of the unit from the manufacturer, Interpretation Systems, Inc. This remains a serious impediment to the interpretation of ERTS images by many of the University of Alaska ERTS investigators, and we are supplying engineering effort to help the vendor solve the remaining problems as quickly as possible.

The Geophysical Institute computer programming section has successfully completed the necessary programs and sub-routines to process the ERTS digital tapes with the IBM 360/40 computer and to reformat the digital data to read into the CDU-200 color digital display system which is currently in the final stage of debugging at the factory. The photographic laboratory has developed procedures for processing the extreme density ranges contained in the NASA-supplied ERTS negatives, and for reconstituting photographically false color photos from the satellite multiband images.

II - STATUS OF PROJECT

We have concentrated on meeting as many specific goals of our overall objectives as possible, and the only goal that we did not achieve is that of an operational digital color display unit. This problem will be discussed in detail in a later section.

A. Objectives

The overall objective of this project is to provide a focus for the entire University of Alaska ERTS-1 effort so as to tie together 12 separately funded projects in 10 disciplines, thus changing multi-disciplinary efforts into an interactive interdisciplinary activity and to achieve significant efficiencies from the sharing of facilities, processing techniques, and contract administration. Our specific goals during this period were: 1) coordination and management of the University of Alaska ERTS-1 program, including the management of the flow of data products, 2) establishment of centralized technical facilities for processing remotely sensed data, and 3) development of digital and photographic techniques for processing and interpreting these data.

B. Accomplishments During the Reporting Period

1) Coordination of Aircraft Program.

The NASA Earth Observations Program mission 209 was conducted with the NASA NP3 aircraft from July 11 to 28, 1972, with the following results:

Project 110-2, 3, 4 and 14 (the 148th meridian transect of Alaska). All flight lines were completed as scheduled except for the predawn flights for line 6, 8 and 10. One of the KA-62 (multispectral) cameras malfunctioned on parts of lines 1 and 3

Project 110-9, (Prince William Sound, Alaska). All flight lines were completed as scheduled except for line 31 which was not attempted owing to the laser profiler sensor being non-operational.

Project 110-12, (Fault line study, Fairbanks area). All flight lines were completed as scheduled. The SLAR flight lines were flown twice to provide data in both vertical and horizontal polarization.

Project 110-13, (Wrangell Mountains, Alaska). All flight lines were completed as scheduled except for lines 39, 40, and 47 which had excessive cloud cover. No laser profiler data were obtained on any of the flight lines because the sensor was non-operational.

Project 110-14, (Nulato and Point Hope, Alaska). All flight lines were completed as scheduled.

On the whole, the aircraft mission is considered to have been very successful. Out of 2,591 miles of flight lines planned, 2,170 miles were completed as scheduled under very favorable weather conditions and 387 unscheduled miles of flight lines were completed at the request of the investigators.

In addition to receiving a copy of aircraft data acquired for the University projects, project 110-1 also received for archival and reproductive purposes, a copy of aircraft data acquired by the NASA NP3A aircraft for the CRREL project SRT-025, (Cook Inlet) and for the USGS project 342-7 (Wolverine Glacier, Gulkana Glacier, Mt. Blackburn).

2) Development of ERTS and aircraft data processing facilities.

The centralized data processing facilities developed and organized by project 110-1 for the University of Alaska ERTS-1 program are listed in figure 1. Project 110-1 has been assigned a large room on the ground floor of the Elvey Building (Geophysical Institute, Room 208). This room was partitioned, remodeled, (at no cost to the project) and equipped to serve as an ERTS data processing laboratory, data library and ERTS users room.

The ERTS data library has been operational since mid-October. It contains ERTS data catalogs and microfilms, copies of all ERTS and NASA aircraft data received by the University projects, (numbering approximately 10,000 photo products thus far), U.S.G.S. maps of Alaska at scales of 1:1,000,000 and 1:250,000, a microfilm view/printer, light tables, roll film transports, magnifiers and ERTS Data Users Handbook and other remote sensing reference literature. A shaded-relief wall map of Alaska at 1:1,000,000 scale provides a convenient reference for interpreting the ERTS prints.

The ERTS data library has been utilized extensively by university investigators and government agencies. It also functions well as an ad-hoc meeting place where ERTS data users coordinate their activities.

The ERTS photoprocessing darkroom adjoins the data library so that ERTS film products can be conveniently checked-out by the photo-technician perfecting data processing techniques (as part of project 110-1) or completing work orders for other investigators. The darkroom includes conventional equipment for color and black & white products. The darkroom also contains two specialized instruments purchased for the ERTS program: A MacBeth densitometer has been calibrated and is used for spectral signature identification and as a quality control device for reproducing ERTS data: a Mark III LogEtronic color and black & white velocity modulated scanning printer has also been calibrated and is used to print the remarkable but difficult ERTS negatives. We have also designed but not yet implemented, a modification of the Mark III printer which will allow its use as a 2X and 4X enlarger.

Owing to the greater than anticipated utilization of the ERTS data library and darkroom, we relocated the color-additive viewer in Room 121 whose narrow and long (40 feet) dimensions will allow projection of registered color images at scales ranging up to 1:250,000 and excellent control of ambient illumination.

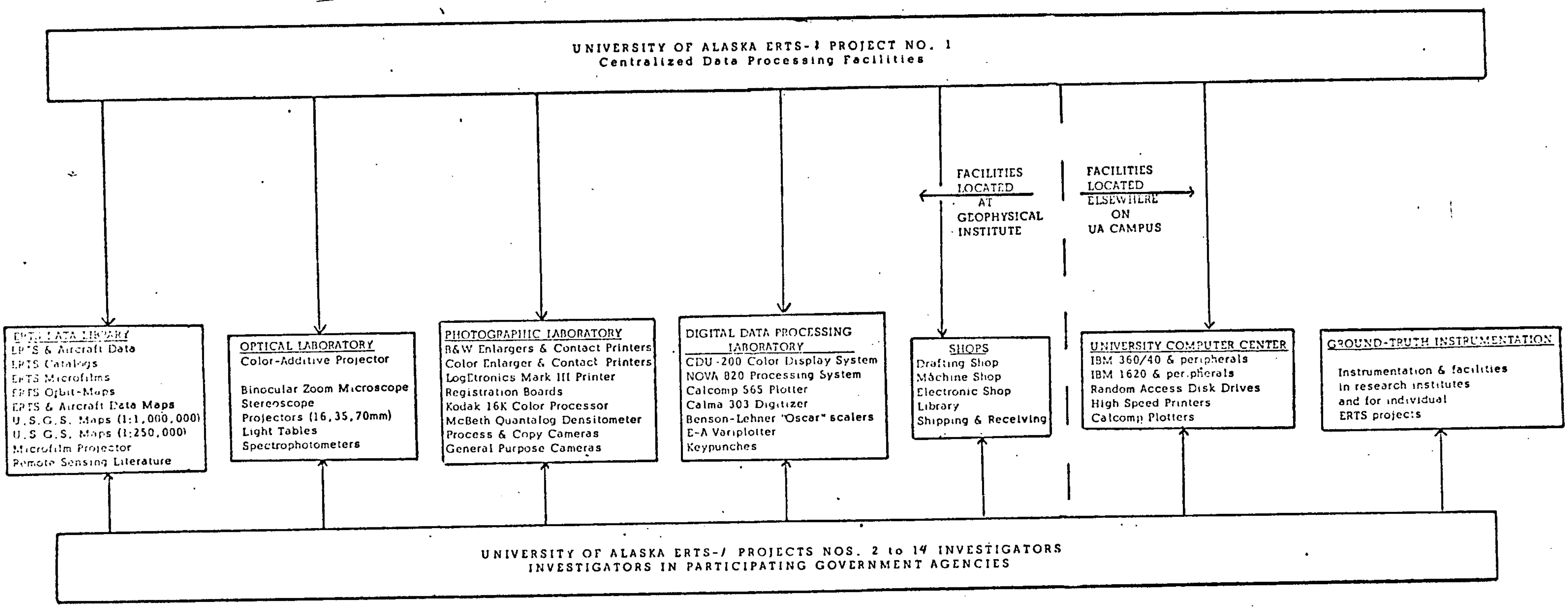


Figure 1 Centralized ERTS Data Processing facilities, U of A ERTS-1 project no. 1

Two color additive viewers were designed and built during the reporting period in the Institute's instrument shop. They consist of four identical 70mm Beseler projectors equipped with 20 inch focal length lenses, adjustable diaphragms and film holders. Registration of the four images is accomplished by adjustments of a specially built film holder in each of the four projectors. The images from all the projectors are projected onto a 24 inch-square polacoat rear-projection screen. The resolution and color filtration achievable with the locally built color additive viewers compare well with commercial units.

One of the color additive viewers is located in the Geophysical Institute for Fairbanks campus investigators' use, while the other is operational at the Institute of Agricultural Science in Palmer, Alaska, for Matanuska Valley and Anchorage area users.

The ERTS digital processing laboratory still awaits the arrival of the CDU-200 color display unit, although conventional digitizers and plotters are operational. Detailed specifications for the CDU-200 were prepared by the University in May and June 1972. Bids for the engineering design and construction of the CDU were solicited from several industrial firms. Contract negotiations were successfully completed in late June with Interpretation Systems Inc., Lawrence, Kansas, which specified an October 28 delivery date.

Further engineering and software details such as the tape format, test tapes, and specifications of contractor provided software were completed by August, and a test tape with numerous patterns for geometric and spectral calibration of the CDU were furnished the contractor in September. Additional engineering refinements were developed in October which promise to provide even greater flexibility and user interaction than was originally conceived. Interface difficulties between the CDU PDP-11 computer, the Kennedy tape drive, and the Xebec controller are causing difficulty in reading magnetic tapes into the PDP-11 minicomputer. The cause of this problem is not definitely known, but it may be related to head skew or alignment difficulties.

An example of increased capability is an additional "read-only" function to be provided by the manufacturer so that the core memory of the PDP-11 can be dumped onto the magnetic tape unit and thus read back in. This entry into the CDU should be much more convenient and reliable than the very slow mechanical paper tape reader. If successful, this feature will greatly aid the development and use of a larger repertoire of programs on the CDU. Another extra feature will be a means to provide for "flickering" at a variable rate between two pictures stored on any of the three disk channels. One possible application of this feature would be to provide a means of detecting subtle differences between spectral bands of an ERTS scene, or between the same scene obtained on different dates.

The combined engineering talents of the Geophysical Institute and Interpretation Systems, Inc. are being applied to resolve the remaining difficulties with the digital display system. The delay in shipment to the University is the cause of our only failure to meet a specific objective for establishing data processing facilities.

3. Development of Digital and Photographic Techniques

It has not been part of our objective to perform research or development on new or unique techniques of image processing or enhancement. Rather, we have concentrated our efforts toward refinement and adaptation of existing, proven techniques to our facilities and the needs of Alaskan investigators. Consequently, we have developed considerable expertise in the reproduction of the magnificent but difficult, 70mm negative products. We have worked at the basic scale of 1:3,369,000 and intermediate scales down to 1:63,360. We have reconstituted color images, with due regard to control of color balance, by four methods: direct photography of the color-additive viewer, the Ektacolor process, the dye-transfer process, and the 3M color-key process. We have also successfully processed ERTS-1 digital tapes and performed relatively simple analyses such as density slicing and signature determinations from training areas. We have programmed and soon plan to execute a modified method of supervised classification.

Figure 2 is a flow diagram of photoprocessing techniques that have been developed during this report period. The photo-reproduction techniques that have been developed and are now available to the U of A ERTS investigators on a custom, but routine, basis are as follows:

a) Production of Black and White Contact Prints and Enlargements.
Normal enlargements to several scales from 1:1,000,000 up to 1:50,000. These are conventional enlargements using essentially the equipment and materials suggested in ERTS Investigators Bulletin no. 13, and LogE (enhanced) prints with long scale and dimensional stability (using type RC printing paper).

Custom prints for specific project objectives.
Alaskan ERTS investigators have indicated a strong preference for prints and transparencies which emphasize only those areas of particular interest to them and their investigations. This preference is often indicated as a substitute for the long scale prints discussed above which represent a compromise effort to retain detail in both highlight (snow, glaciers, barren ground) and dark areas (water, shadows, some vegetation types).

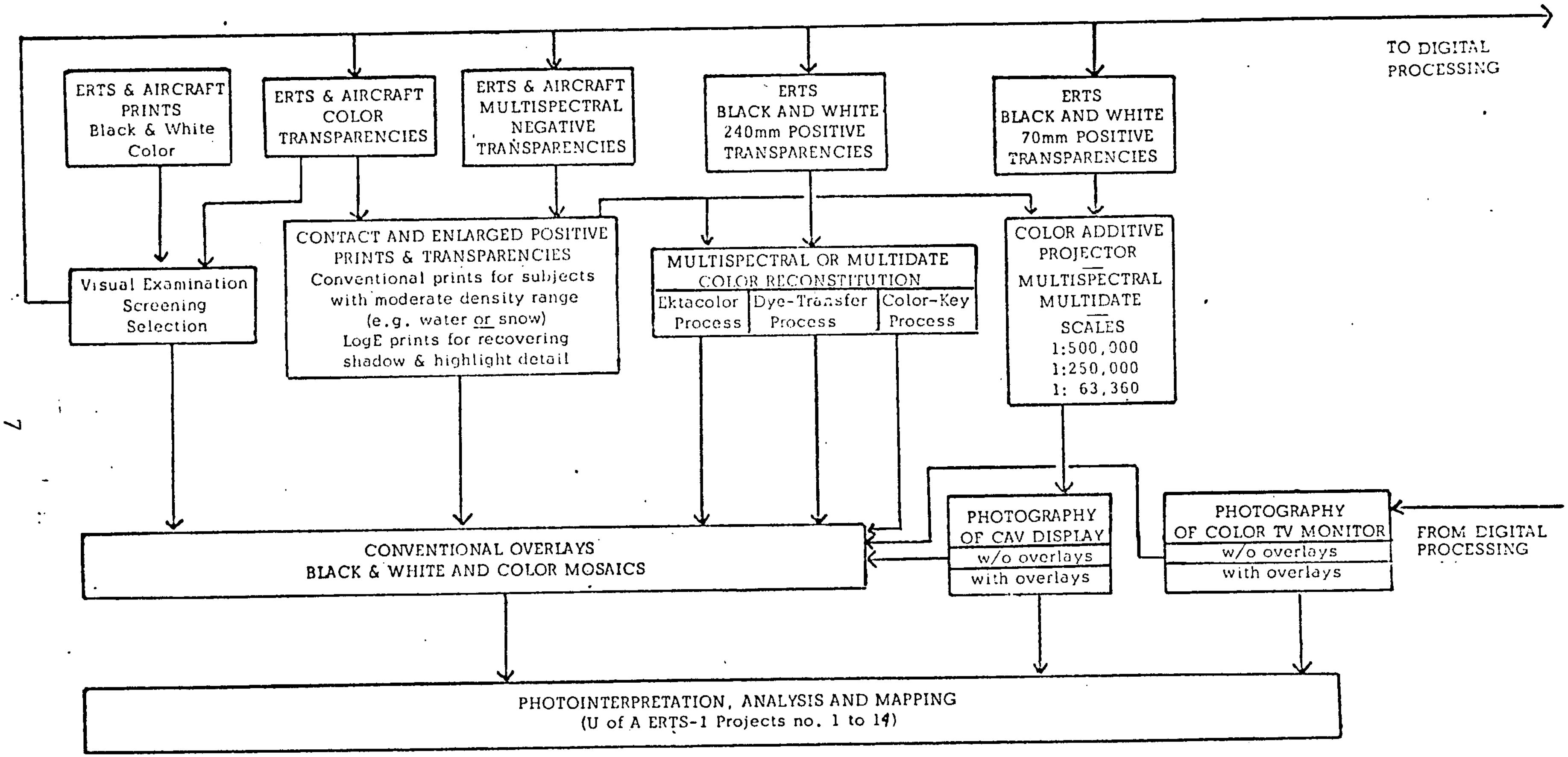


Figure 2. Optical and Photographic Processing, U of A ERTS-1 Project No. 1

We are therefore using the very long scale ERTS negative as a master from which we can produce new negatives for making high quality prints and transparencies featuring any of the three regions of interest: near toe (dark scene areas), middle scale (vegetation), and near shoulder (snow and ice). In this manner we can provide greatly expanded grey scales for each of these regions, thus gaining higher information content in the final print or transparency.

Large scale film positive enlargements for use as direct overlays on maps, grids, charts and ground truth data.

Black and white positive transparencies for the color-additive viewer. These transparencies are made from 70mm negatives of entire ERTS scenes (when particular features must be enhanced) or sections thereof (to provide for a wide range of enlargements) and from multispectral or multidate aerial photographs.

b) Production of color composite photographic products:
We have developed five techniques so far for producing color images of ERTS and aircraft data.

3M color-key process. This process involves the reproduction of ERTS data on a screened transparency to the same scale as the finished color product (usually 1:1,000,000). The screened transparencies for each MSS band are then used to produce inexpensive colored separation overlays in cyan, magenta and yellow and/or blue, green and red. We are using a 200 lines per inch screen corresponding to a ground resolution of 125 meters for a 1:1,000,000 scale transparency; therefore no loss of ERTS data resolution results at this and larger scales. The chief advantages of the color-key process are:

--it allows the investigator to reconstitute color images from multispectral or multidate data products in any combination and at his desk without the use of special equipment.
--registration of the color overlays is quickly and accurately achieved.
--the cost of the finished overlays is lower than that of other color printing products.

Ektacolor process (type C). Considerable interest has been expressed by the U of A ERTS investigators in the production of Type C color prints (Ektacolor) made from color negatives which are produced by successive (multiple) exposures of 240mm ERTS positive black & white transparencies placed in register on a light table (5000°K color temperature illumination).

Ektacolor process (type R). Type R (direct) color prints of aerial color positive transparencies are routinely produced. The use of the LogE printer is essential in this process because it produces quality prints of scenes having a relatively great brightness range.

Dye-transfer process. This technique provides the highest quality and resolution of any color printing system; however prints produced by the dye-transfer process are much more costly than those produced by the techniques mentioned earlier. Therefore we will continue to offer this technique to the U of A ERTS investigators, but, because of its cost, we do not anticipate numerous requests for dye-transfer prints.

Color positive and negative transparencies of ERTS scenes produced by photographing the displays of the color-additive viewer. Color prints to any scale will be made by the Ektacolor processes type C or R.

c) Digital data processing.

U of A ERTS-1 project no. 1 provides the means to allow the various ERTS investigators to make efficient and practical use of the digital data as supplied by NASA. To accomplish this, project no. 1 has provided computer software and hardware for the investigators' use and also training and assistance for the investigators.

One of the principal items of hardware yet to be provided is the Color Display Unit (CDU-200) being manufactured by Interpretation Systems Inc. of Lawrence, Kansas, according to our design specifications. This device is illustrated in figure 3 in the form of a simplified block diagram. Basically the CDU-200 is a color TV with a digital computer compatible tape input. Additional features allow for both analog and digital manipulation of the data prior to presentation on the 25" color monitor.

Some hardware already existing at the University has been adapted to ERTS applications and includes the IBM 360/40 and its peripherals, Cal-Comp plotters, a Calma Model 303 digitizer, and other miscellaneous data processing equipment. This equipment is listed in figure 1.

Software has been developed for both the IBM 360 and the PDP 11/05 which is part of the Color Display Unit. Figure 4 shows the data handling scheme as developed to-date (Jan. 73). Most of the effort until now has been devoted to development of programs to handle the bulk MSS Tapes.

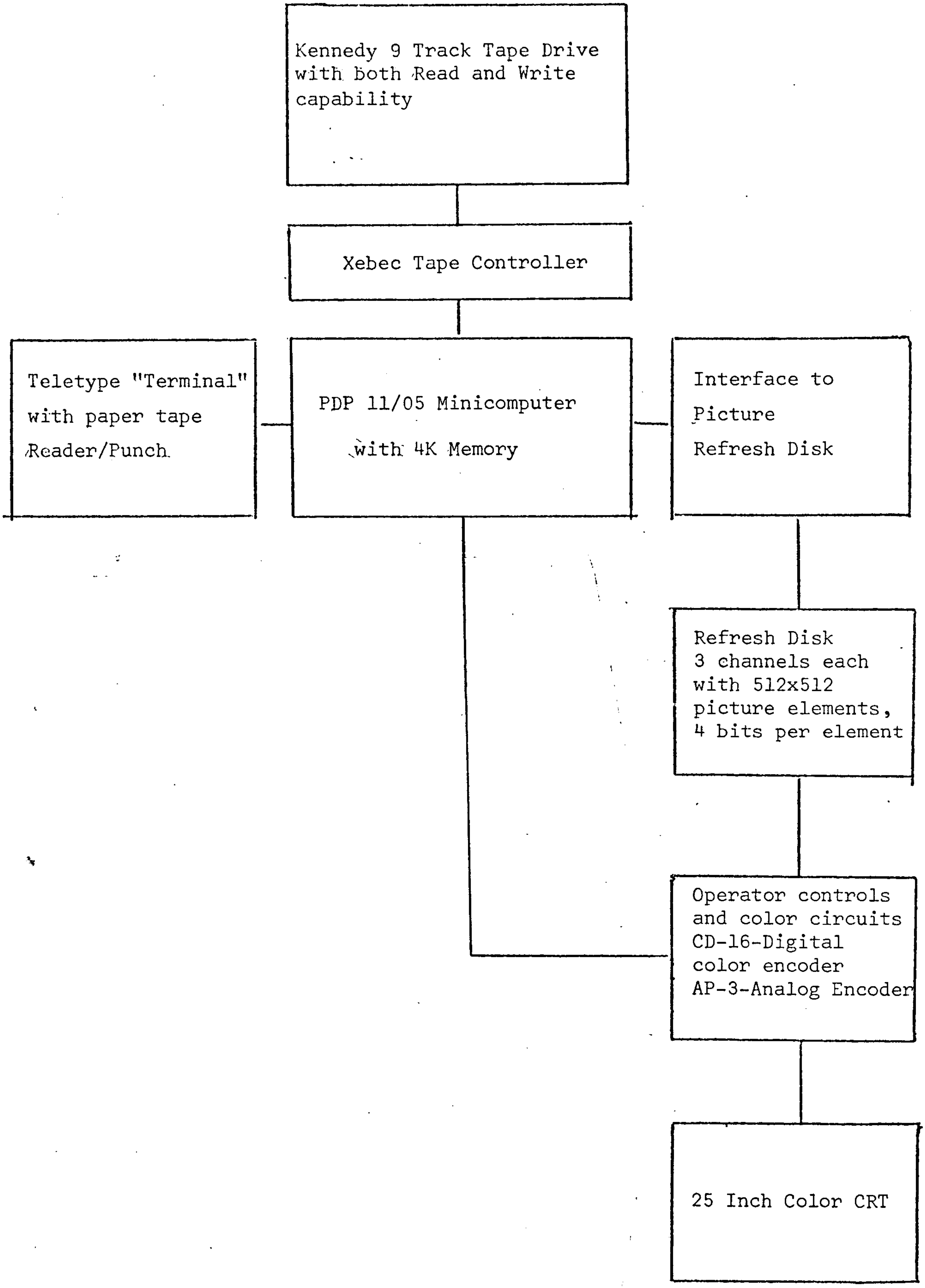


Figure 3, Simplified Block Diagram of CDU-200

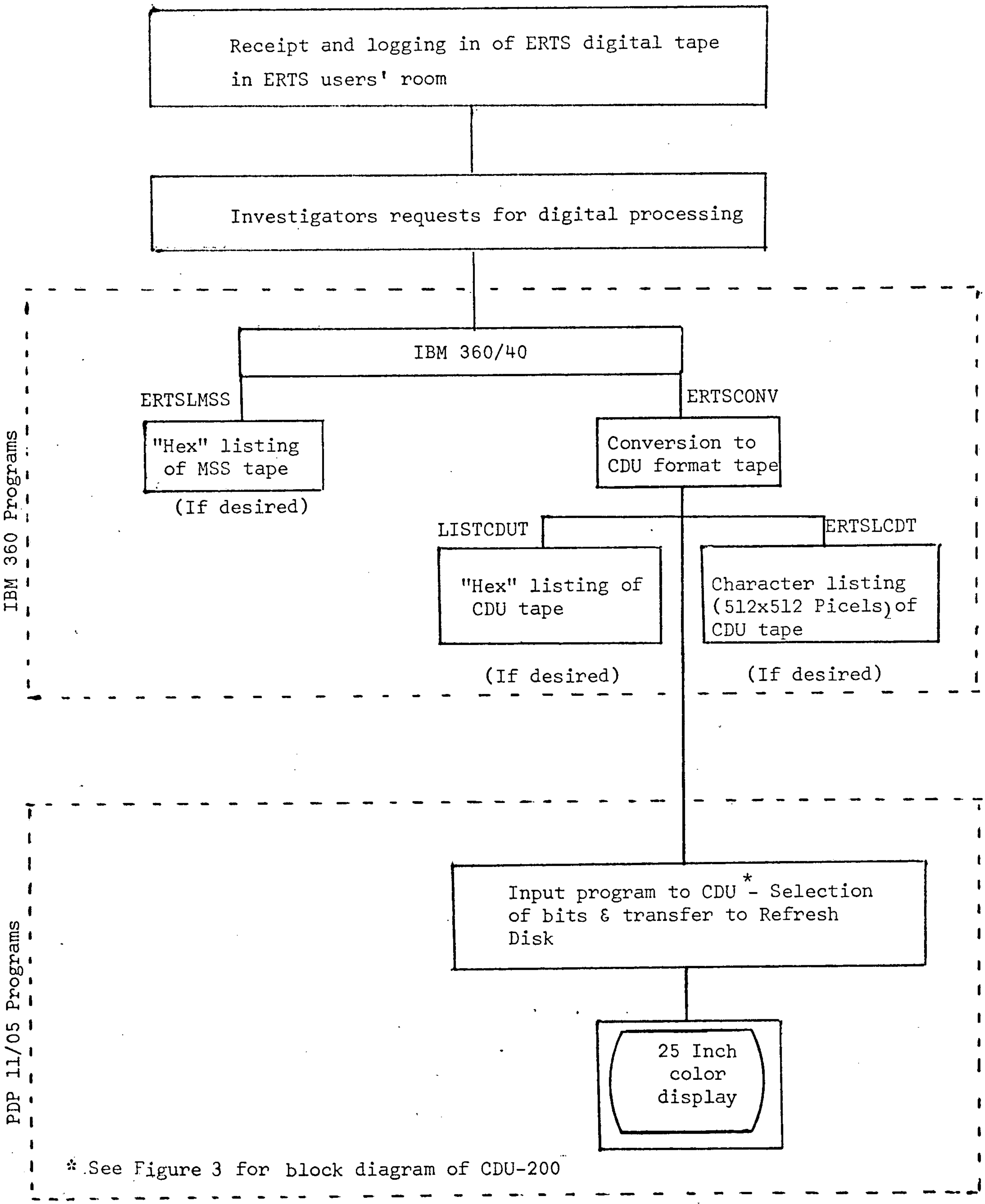


Figure 4 - Present (Jan. '73) ERTS Digital Data Handling

"ERTSLMSS" provides a "hexidecimal" type listing of scan lines as selected by control cards and lists all identifying and annotation information on the tape. This program is primarily intended as a check-out and debugging tool but may also be useful to an investigator who wishes to have a detailed printout of the levels in each band for each picel.

"ERTSCONV" converts a portion of a MSS Tape format which allows for 512 scan lines of 512 picels each. Control cards allow for the selection of the starting scan line, the starting picel number, the band to be converted, and for the identification to be placed on the CDU Tape.

"LISTCDUT" provides a hexidécimal listing of selected portions of a CDU Tape. This program was developed primarily as a check-out and debugging utility for the CDU Test Tapes prepared for Interpretation Systems Incorporated's use in testing the CDU-200 but it may prove useful to the ERTS investigators in some applications.

"ERTSLCDT" provides a character type listing of a CDU format tape. Any of the 48 available characters can be assigned to any of the intensity levels for each band on the original MSS Tape. A detailed isointensity or contour printout is the result. These have proven to be very useful in allowing an investigator to define the spectral signature of a known feature in training areas.

The CDU has the feature of being able to write on the magnetic tape the contents of the refresh disk. This feature will be very valuable where it is desirable to check results of a CDU operation on a picel by picel basis as the tape can be read by the 360 and listed in detail. Complete intercommunication and compatibility between the 360 and the CDU are also assured by this feature.

The CDU format tapes are input to the CDU via a PDP 11/05 program developed by ISI. In addition to providing a means of transferring the data from the tape to the disk refresh memory via the PDP 11/05, considerable data manipulation is possible with the CDU and the PDP 11/05 and, if desired, the results of these manipulations can be written out in the standard CDU format on tape again. This tape can then be processed again, if desired, using the programs already developed for the IBM 360.

As can be seen from the above, only the basic framework has been developed so far. It will be necessary to develop considerable additional software for both the 360 and the PDP 11/05 during the remainder of the ERTS 1 project.

4. Coordination of University of Alaska ERTS Activities

The incoming flow of ERTS and Mission 209 aircraft data became an overwhelming flood during October, November and December. Since the spacecraft ceased acquiring Alaskan imagery on November 5, 1972, due to low sun angles, the flow of data slackened somewhat in January. Several thousand frames of aerial images and over 10,000 ERTS data products were received, catalogued, filed and transmitted to the appropriate investigator in a timely manner. Experience has demonstrated conclusively that utter chaos would have resulted if this volume of data would have been shipped individually and directly to each project. The myriads of important details concerning ordering, acknowledgement receipts, partial shipments, short shipments, and misshipments could not conceivably been coped with other than through a central data handling facility.

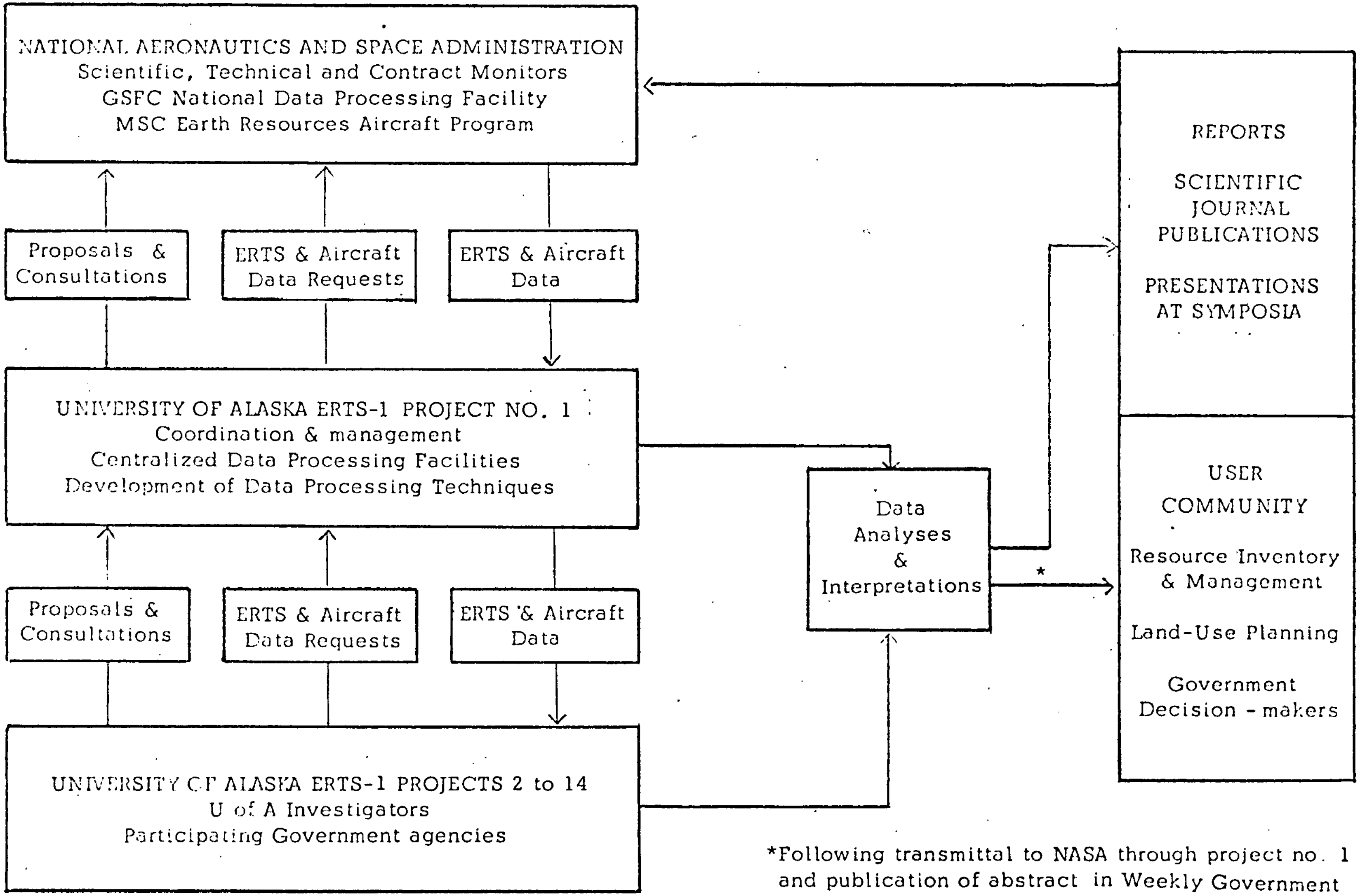
The flow of ERTS and aircraft data through the entire U of A ERTS program is illustrated in Figure 5. Basically the central switchboard for the flow of data and results is the U of A ERTS Coordination Office and its ERTS Data Library. Neither of them is funded by this project, but they have been implemented nevertheless because we feel that they are essential to the successful performance of the twelve U of A ERTS projects.

ERTS standing and retrospective data orders, aircraft support and data requests, data queries and other inquiries are initiated by the individual investigators with the assistance of the ERTS Coordination Office and they are sent to NASA/GSFC by the U of A ERTS Data Library.

The received data are logged in, checked against the data orders and one copy of each data product is transmitted to the individual investigators within one to three days of receipt, depending on the flow of incoming data. Lists are made of data received by each investigator, data ordered but not received, and data of inferior quality which should be reprocessed by NASA as the investigator wishes. Eventually new data requests are made for the latter two categories of data.

The principal investigator screens the data that he has received, selects scenes that he decides to analyse, and selects a data processing plan from the list of available plans prepared by U of A ERTS-1 project no. 1. Then he consults with scientific and technical personnel of project no. 1, revises the data processing plan, if necessary, and issues a work order for processing the data. In some cases the investigator may process the data himself, or participate in the data processing.

Once the investigator has examined the processed data products, he proceeds to the interpretation of the data with or without the assistance of the U of A scientific coordinator. A draft manuscript of the publication proposed by the investigator is provided to the scientific coordinator of U of A ERTS-1 project no. 1 who edits it and, if necessary, makes or suggests revisions.



*Following transmittal to NASA through project no. 1 and publication of abstract in Weekly Government Abstract

Figure 5. Data Flow for University of Alaska ERTS-1 Program

The publication is then sent to NASA, and upon approval by NASA and publication in the Weekly Government Abstracts, the manuscript is sent to interested government users and, in appropriate instances, to scientific journals.

It is to be noted that the data used in processing the work orders of individual investigators are the copies of data products filed in the ERTS Data Library, not the investigators' copies of data products. The reason for this approach to data handling is twofold: firstly the individual investigators can use their copies of the data as working data products, and they can be assured that a clean, unscratched copy of their data is available in the ERTS data library for reproduction and processing; secondly, the availability of a copy of all data products in the ERTS data library avoids the cumbersome transfers of data between the various research institutes and the Geophysical Institute where the centralized ERTS data processing facilities are located.

U of A ERTS-1 project no. 1 has submitted a separate standing order for ERTS scenes of Alaska with twenty percent cloud cover or less. The purpose of this order is the development of data processing techniques for a wide variety of Alaskan scenes and disciplinary applications and the use of government agencies in Alaska. These data will be handled in essentially the same way as the other investigators' data products.

Throughout the reporting period, personnel of project 110-1 were constantly in contact with University investigators, assisting them with the administration of their ERTS contracts, data processing, analysis and interpretation activities as well as in preparation of reports.

An additional feature of our coordination activities was a special ERTS presentation at the 2nd Annual Alaska Earth Sciences Planning Conference, at which an entire day was devoted to the impact of ERTS data upon the earth science disciplines. This conference was held at the Geophysical Institute on November 2-4, 1972, and included presentations of current ERTS activities by the University of Alaska, the U.S. Geological Survey, the U.S. Bureau of Sports Fisheries and Wildlife, and the U.S. Army Cold Regions Research and Engineering Laboratory. Besides the presentations by the various agencies of their ERTS activities, the conferees also devoted time to a visit to the University facilities described in this report, and to working group discussions among the participants. Attendance at the ERTS session of the conference averaged about 60 persons representing major government agencies and University departments involved with environmental research.

Education and training in remote sensing techniques was also a major effort of Project 110-1 during this report period. An intensive short course on the physical basis and applications of remote sensing was conducted December 13 - 20, 1972, at the Geophysical Institute for University

investigators as well as personnel from many federal, state and local government agencies. The intensive, 6-day short course presented the following topics:

Classification of Remote Sensing Systems
The Electromagnetic Spectrum
Spectral Characteristics of Natural Materials
The Systems Approach to Remote Sensing
Radiation and Sensor Characteristics
Photographic Products & Custom Processing
Principles of Photo Interpretation
Interpretation of Multispectral data
Atmospheric Effects
Image Enhancement and Color IR Interpretation
Hydrology Applications
Geology Applications
Vegetative Applications
Land Resource Analysis
Oceanography Applications
Remote Sensing and the Computer
The Color Additive Viewer
The Digital Color Display Unit

Attendance during the course averaged about sixty persons. Material for presentation was adapted in part from a two week short course in remote sensing presented by the Laboratory for Applications of Remote Sensing, Purdue University, in July 1972, and the four week USDI/EROS Data Center remote sensing course presented in Sioux Falls, S.D. in November 1972. The Purdue and Sioux Falls courses were complementary to one another in that the Purdue presentation emphasized digital processing almost entirely, and the Sioux Falls course considered photographic interpretation almost exclusively. J.M. Miller, co-investigator on Project 110-1, attended both courses at Purdue and Sioux Falls, and organized the University of Alaska short course using five additional University speakers.

Other activities were aimed at informing the public of the applicability of ERTS images to the Alaskan environment. A series of five-minute radio interviews was broadcast on a 50,000 watt local broadcast station daily for an entire week. This format was an informal discussion in laymen's terms of remote sensing and ERTS images and how they relate to some of the needs of Alaskans today. The local daily newspaper was brought into the University's ERTS activities, and ran a full color-IR ERTS photo of the Fairbanks region on the front page of the December 12 issue. This is believed to be the first publication of an ERTS photo in full color by any daily newspaper.

5. Application of ERTS-1 data

Several typical Alaskan ERTS scenes were utilized in the development of our image processing techniques.

Scene 1009-22095 of Seward Peninsula was studied from the point of view of vegetative and geologic mapping as part of our objectives to develop ERTS data processing and interpretation techniques. Individual bands were studied from 9.5 inch prints and projected 70mm positive transparencies. Composite color-infrared prints were made from MSS bands 4, 5 and 7 using the Ektacolor process and varying the color balance to enhance specific features.

The vegetation analysis was conducted in cooperation with project 110-3 and revealed seven major color differences which were interpreted to represent shrub thicket, upland tundra, coastal wet tundra, alpine barrens, grassland tundra, senescent vegetation and tundra burn scars. The first four types are well described by existing vegetation maps, although the ERTS scene shows that the shrub thicket exists not only in the southern part of the scene as vegetation maps indicate, but also throughout the western part as a pattern following stream beds. The last three vegetation types are not represented on existing vegetation maps.

The geological analysis was conducted in cooperation with project 110-13. In general the result of this analysis agreed very well with existing geologic and tectonic maps with two exceptions. The ERTS scene analysis could not differentiate between small outcrop of rocks which the geologic maps identified either as granite intrusives or as metamorphic rocks. On the other hand the ERTS scene revealed a dumbbell-like drainage pattern in the northern part of the same geologic pattern. The geologic map shows only the right part of the dumbbell and identifies it as a granitic intrusion which is in fact seen on the ERTS scene as a small outcrop. No outcrop is seen at the center of the left part of the dumbbell, but the drainage pattern suggests that a buried granitic intrusive may be present. This is quite significant because tin deposits on the Seward Peninsula are found in these granitic intrusions.

Scene 1029-20383 (Big Delta, Alaska) was selected for enhancement studies because much ground truth is available and the scene represents a broad range of terrain types: wilderness mountain areas, glacial and clear water streams, cultural features, and some rare agricultural activities in the interior of Alaska. The scene was studied in detail using false color composites produced by the 3M color-key process, a color additive viewer at the EROS Data Center, and a digital display unit at South Dakota State University. In general the three techniques achieved the same results qualitatively, but once the features and subtle differences were recognized with the photographic techniques, the use of digital techniques and color-coding capabilities afforded a superior degree of enhancement.

The reconstituted color images discriminate very well between the clear water of streams draining watersheds with vegetative cover from the turbid water of glacier-fed rivers. It is also possible to differentiate shallow water from deep water in lakes of varying depth. Old forest fire burns are very well revealed in false color enhancement, not so much because northern ecology is slow to heal but in this case because a different type of vegetation, aspen and birch, grew to replace the original habitat of black spruce which existed fifty years ago. Apparently the rehabilitation and change of vegetative cover after natural or man-made disturbances occur will be easily monitored by space data over very long periods of time.

This scene reveals that prevalent winds raise a column of dust and sand, 2 km wide and up to 50 km long, from the dry wash bed of the Delta River and cause a severe air pollution problem in an area which may be subject to development in the near future.

Finally a characteristic dashed and zig-zag line in old terminal moraines suggests that the Mt. Hayes glacier, which is now retreating, was once a surging glacier.

III - NEW TECHNOLOGY

The University of Alaska and Image Interpretation Systems Inc. are developing a new and highly versatile color display unit with data manipulation and user interaction capability; however since this equipment is not yet delivered and tested we will describe it in future reports.

IV - PLANS FOR NEXT REPORTING PERIOD

February - March 1973

The primary unfulfilled goal of project 110-1 is the installation and checkout of the CDU-200 digital color display unit. Two engineers from the Geophysical Institute's research support group will visit the ISI plant in Lawrence, Kansas, to aid in isolating and debugging the cause of the inability to reliably read our magnetic tapes into the PDP-11 minicomputer. These engineers have had considerable experience in troubleshooting digital logic circuitry and tape drive and control problems. The delivery of this vital part of the University ERTS program is already four months delayed and we shall make every effort to bring the system into operational readiness by the end of March.

February-July 1973

Coordination and management activities will continue at a slightly reduced level, although there will be a continuing need especially for consultation with various investigators regarding specific problems with data processing or interpretation. The establishment of data processing facilities should become complete once the digital color display unit is installed.

Additional attention must remain on the photographic laboratory which will be playing an increasingly central role in the overall University ERTS program. It is expected the volume of ERTS related work will increase sharply during the second half of the contract period. Since this increasing work load is funded by other projects or agencies, there will be no budgetary impact on project 110-1 funds, but prudent management will be necessary to ensure adequate personnel and resources to avoid intolerable delays in completing work requests.

The development of additional computer programs for digital analyses of ERTS data will continue, and at an accelerated pace once the CDU is delivered. Whether a certain program or data manipulation function should be developed for the IBM 360 or the PDP-11 in the CDU will depend upon many factors. It is obviously desirable to implement as many manipulations as possible on the CDU itself, because this will allow the investigators the opportunity to see the result immediately and to interact with it. Experience which can only be obtained after the CDU system is installed will be a major factor in guiding the course of future development of the software packages. Table 1 is a list of the various programs which are proposed for development during the next six months. Emphasis will be placed upon those programs in which the ERTS investigators show the greatest interest. Also, it is quite probable that needs not now foreseen will become evident, so this list is not final.

The necessary photographic data processing techniques have been developed and they are now routinely utilized by the ERTS investigators. This phase of project 110-1 activities is essentially complete. For the remainder of the contract period we only plan to refine, standardize and calibrate further the processing techniques to the extent allowed by the very limited funds available for this purpose.

TABLE 1 - Planned Software Development

Device	Program Description	Comment
360	Convert RBV and Precision tapes to CDU tape format.	If requested by investigators. Present emphasis on MSS bulk data for which "convert" software is already developed.
360	Load onto direct access disk for extended processing.	Needed particularly if differences in image taken at different times are to be studied.
360	Variations of ERTSCONV (convert to CDU tape) program. 1. Insertion of alternate scan lines to correct aspect ratio 2. Picel deletion or averaging to form 25 X 25 NM CDU tape files 3. Picel averaging to provide whole scene on CDU tape file.	There are many possibilities for deriving the 512 X 512 picel CDU pattern files from the original data. Some of these will require that all data for a scene be available, and thus require loading onto a direct access disk prior to conversion to a CDU file.
360	Unsupervised classification. Adaptation of parts of maximum likelihood analysis schemes such as Purdue's LARSYS.	Because of large computer time requirements it is expected that unsupervised classification will be useful only for small areas rather than whole scenes.
360 CDU?	Supervised classification type 1. Coordinates of test (or training) area given to computer which then finds all "similar" areas.	More suitable for 360 but possible on CDU after considerable software development.
360 CDU	Supervised classification type 2. Investigator specifies intensity levels for each band which define area to be classified.	Presently being developed for 360 using CDU format tapes for input and output. Eventual development for CDU expected.
360 CDU	Generation of new pattern files from interband ratios, sums, differences and possible other arithmetic manipulations.	Presently being developed for 360 using CDU format tapes for input and output. Some analog manipulation possible on CDU without software development. Eventual development of a repertoire of manipulation expected for CDU.
CDU	Intensity slicing.	Built-in feature of CDU. Possible variations with software development including contouring of intensity sliced images by blocking out selectable levels.
360 CDU	Tabulation of areas or acreages classified by previous programs.	Output on teletypewriter on CDU.
360	Frequency distributions, histograms and other presentations to assist in signature analysis, etc.	Expected to be primarily "one-shot" programs to assist a particular investigator and not worth programming on CDU.

V - CONCLUSIONS

The approach that we proposed in establishing central facilities and coordination activities to serve all University of Alaska ERTS projects repeatedly has been proven exceptionally sound during the report period. The level of supporting services available to each investigator has been multiplied by the activities of project 110-1. Rather than twelve separate projects striving individually to marshall facilities, services and techniques, we have achieved the effectiveness of shared hardware, shared techniques, and shared results. Although the level of effort required to achieve these rather impressive results from project 110-1 far exceeds the scope of work agreed in the contract, we felt that the future of the ERTS program in Alaska absolutely demanded this degree of effort. Appraisals from objective outside observers of the University ERTS program to date have been uniformly enthusiastic. The benefits of project 110-1 achievements should be felt well into the future by those investigators who will be working with Alaskan remote sensing data, whether they be located inside or outside the State of Alaska.

VI - RECOMMENDATIONS

Not only must the coordinative activities concept grow if the University ERTS program grows in the future, but it may well have to expand proportionally to the growth of the scientific <u>and</u> administrative aspects of future programs. It has never previously been our experience to invest as much effort toward pseudo-administrative matters, such as completion of questionnaires, preparation of technical and financial reports, response to special NASA requests, compared to the amount of research support provided by this ERTS-1 contract. In this program there appears to be a disturbingly small ratio of science supported versus administration required. It is recommended that both the University and NASA re-evaluate the need for and the ability to provide for such complex administrative functions in the future.

VII - PUBLICATIONS

None

VIII - REFERENCES

None

APPENDIX A - CHANGE IN STANDING ORDER FORMS

Original order date: 6/20/72
Revised order date: 11/07/72

APPENDIX B - ERTS DATA REQUEST FORMS

Submitted:

22 August 1972	(data received)
24 August 1972	(data received)
31 August 1972	(data received)
13 October 1972	(data received)
09 November 1972	(combined with data query-data not received)
09 November 1972	(data received)
21 November 1972	(data partially received)
24 November 1972	(data partially received)
18 January 1973	(data not received)
18 January 1973	(data not received)
24 January 1973	(data not received)

APPENDIX C - ERTS IMAGE DESCRIPTOR FORMS

ERTS IMAGE DESCRIPTOR FORM

(See Instructions on Back)

NDPF USE ONLY
D
N
ID

DATE January 31, 1973

PRINCIPAL INVESTIGATOR Albert E. Belon

GSFC U 318

ORGANIZATION Geophysical Institute, University of Alaska

PRODUCT ID (INCLUDE BAND AND PRODUCT)	FREQUENTLY USED DESCRIPTORS*					DESCRIPTORS
	Mtn.	Tundra	River	Coast	Snow	
1002-21310	x	x	x			Lake
1008-20220	x		x		x	Glacier
1029-20383	x	x	x			Highway
1030-20442			x			City, Lakes
1037-21231	x	x	x		x	Lake
1037-21234	x	x	x			Forest burns
1039-21371		x	x	x		Sedimentation
1049-20505	x	x	x	x		City
1054-21203		x	x	x		Sedimentation
1062-20221	x		x		x	Volcano
1073-21223		x	x	x	x	Ice
1073-21225	x	x	x		x	
1073-21232	x	x	x		x	Lake
1009-22095	x	x	x	x		Lagoons

*FOR DESCRIPTORS WHICH WILL OCCUR FREQUENTLY, WRITE THE DESCRIPTOR TERMS IN THESE COLUMN HEADING SPACES NOW AND USE A CHECK (✓) MARK IN THE APPROPRIATE PRODUCT ID LINES. (FOR OTHER DESCRIPTORS, WRITE THE TERM UNDER THE DESCRIPTORS COLUMN).

MAIL TO ERTS USER SERVICES
CODE 563
BLDG 23 ROOM E413
NASA GSFC
GREENBELT, MD. 20771
301-982-5406

GSFC 37-2 (7/72)

APPENDIX D

SEMI-ANNUAL PROGRESS REPORT

UNIVERSITY OF ALASKA
PROJECT 110-1

January 31, 1973

PRINCIPAL INVESTIGATOR: Albert E. Belon / GSFC ID U318

TITLE OF INVESTIGATION: Coordination and Establishment of Centralized Facilities and Services for the University of Alaskan ERTS Survey of the Alaskan Environment.

DISCIPLINE: Interpretation technique development

SUBDISCIPLINE: Land-Use Planning

SIGNIFICANT RESULTS:

Scene 1072-21173 of the Anaktuvuk Pass region of the Brooks Range, Alaska, was studied from the point of view of a resource survey for purposes of land use planning as part of our effort to develop ERTS data processing and interpretation techniques. Color and black & white prints in the 240mm format were analyzed in cooperation with the Resource Planning Team of the Federal-State Land Use Planning Commission for Alaska. Other data sources and surface observations were utilized to produce a resource survey of a remote and undeveloped region of Alaska.

Three vegetative types are apparent--moist tundra is discernible on the outwash plains and on gentle slopes; low brush is evident in the narrow stream valleys flowing northward, but in the plains it becomes intermittent and yields to tundra types; and high brush is found in the southern aspects of the stream valleys on the south slopes of the Brooks Range.

Watersheds are easily defined on the multispectral imagery. Four drainages slope toward the Arctic Ocean, and five watersheds drain into the Koyokuk and Yukon river systems. All drainages are rugged, steep-sided mountain basins with swift flowing streams and steep gradients.

Features related indirectly to economic minerals are discernible from ERTS imagery supported by ground-truth data. These include mountains, outwash plains and alluvial deposits, drainage patterns, lineaments and probable bedding planes. The southern half of the Brooks Range is predominantly metamorphosed Devonian strata and not expected to be petroliferous. The northern half of the Range is structurally complex late mesozoic rocks which are not metamorphosed, and could be petroliferous.

The central disturbed belt results from extensive thrust faulting associated with the development of the Brooks Range. The possibility of limestone and sandstone reservoirs occuring beneath this belt at depths of 15,000 feet makes it a potential petroleum area.

Recreational opportunities are limited because of access difficulties. The major hunting and fishing areas are near Big and Twin Lakes, Wild Lake, and Chandler Lake. These activities are limited to Dall Sheep, caribou and lake trout.

This region falls within present land class categories which are not inconsistent with the imperatives of the resources. These land class categories include native village withdrawals, regional deficiency area, national interest study area (D-2) for possible inclusion in a national system, public interest areas (D-1), utility corridor, and state land selection.